WHAT IS CLAIMED IS:

1. A signal processing method for processing a visible light image signal and infrared image signal obtained by illuminating a transparent document with light beams respectively coming from a visible light source for mainly emitting visible light and an infrared light source for mainly emitting infrared light, and photoelectrically converting optical images of the transparent document, comprising:

a generation step of generating a histogram on the basis of the infrared image signal;

a calculation step of calculating a threshold value on the basis of the histogram generated in the generation step;

an extraction step of comparing the threshold value calculated in the calculation step with infrared image signal components, and extracting infrared image signal components not more than the threshold value; and

an interpolation step of executing an interpolation process of the visible light image signal on the basis of the infrared image signal components extracted in the extraction step.

2. The method according to claim 1, wherein the interpolation step includes the step of interpolating visible light image signal components corresponding to the infrared image signal components extracted in the

extraction step using surrounding visible light image signal components.

3. The method according to claim 1, wherein the interpolation step includes the step of interpolating visible light image signal components, which correspond to an image region corresponding to the infrared image signal components extracted in the extraction step, and a region obtained by enlarging the image region by a predetermined size, using surrounding visible light image signal components.

4. The method according to claim 1, wherein the interpolation step includes the step of interpolating visible light image signal components, which correspond to a region obtained by reducing a region corresponding to the infrared image signal components extracted in the extraction step by a predetermined size, using surrounding visible light image signal components.

5. The method according to claim 1, further comprising an edge correction step of performing edge correction of the infrared image signal,

wherein the generation step includes the step of generating the histogram on the basis of the infrared image signal that has undergone edge correction, the extraction step includes the step of extracting infrared image signal components not more than the threshold value by comparing the threshold value calculated in the calculation step with the infrared

image signal components that have undergone edge correction, and the interpolation step includes the step of interpolating visible light image signal components corresponding to the infrared image signal components extracted in the extraction step using surrounding visible light image signal components.

6. The method according to claim 5, wherein an edge correction amount in the edge correction step is set in association with the deterioration of the MTF of the visible light source and said infrared light source due to chromatic aberration.

7. The method according to claim 1, wherein the generation step includes the step of generating a histogram of frequencies of occurrence of respective gray levels of the infrared image signal.

8. The method according to claim 7, wherein the calculation step includes the step of calculating the threshold value by subtracting a value given by a predetermined relation from a gray level that represents the infrared image signal.

9. The method according to claim 8, wherein the calculation step further comprises:

a step of calculating a standard deviation; and

a step of determining the value to be subtracted on the basis of the standard deviation.

10. The method according to claim 7, wherein the calculation step comprises:

a step of calculating an intermediate value of the frequencies of occurrence of the histogram; and

a step of calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the intermediate value.

11. The method according to claim 10, wherein the predetermined value is pre-stored.

12. The method according to claim 10, wherein the predetermined value is externally input.

13. The method according to claim 10, wherein the calculation step further comprises:

a step of calculating a standard deviation; and

a step of determining the predetermined value on the basis of the standard deviation.

14. The method according to claim 7, wherein the calculation step comprises:

a step of calculating a maximum frequency of occurrence of the histogram; and

a step of calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the maximum frequency of occurrence of the histogram.

15. The method according to claim 14, wherein the predetermined value is pre-stored.

16. The method according to claim 14, wherein the predetermined value is externally input.

17. The method according to claim 14, wherein the calculation step further comprises:

a step of calculating a standard deviation; and

a step of determining the predetermined value on the basis of the standard deviation.

18. The method according to claim 7, wherein the calculation step comprises:

a step of calculating a maximum gray level of the histogram; and

a step of calculating the threshold value by subtracting a predetermined value from the maximum gray level.

19. The method according to claim 18, wherein the predetermined value is pre-stored.

20. The method according to claim 18, wherein the predetermined value is externally input.

21. The method according to claim 18, wherein the calculation step further comprises:

a step of calculating a standard deviation; and

a step of determining the predetermined value on the basis of the standard deviation.

22. The method according to claim 7, wherein the calculation step comprises:

a step of calculating an average gray level of the histogram; and

a step of calculating the threshold value by subtracting a predetermined value from the average gray level.

23. The method according to claim 22, wherein the predetermined value is pre-stored.

24. The method according to claim 22, wherein the predetermined value is externally input.

25. The method according to claim 22, wherein the calculation step further comprises:

a step of calculating a standard deviation; and

a step of determining the predetermined value on the basis of the standard deviation.

26. The method according to claim 7, wherein the calculation step comprises:

a step of calculating a maximum gray level of the histogram; and

a step of calculating the threshold value by multiplying the maximum gray level by a predetermined value.

27. The method according to claim 26, wherein the predetermined value is pre-stored.

28. The method according to claim 26, wherein the predetermined value is externally input.

29. The method according to claim 7, wherein the calculation step comprises:

a step of calculating a maximum gray level of the histogram;

a step of calculating an average gray level of the histogram; and

a step of calculating the threshold value by subtracting a product, which is obtained by multiplying a difference between the maximum gray level and the average gray level by a predetermined value, from the average gray level.

30. The method according to claim 29, wherein the predetermined value is pre-stored.

31. The method according to claim 29, wherein the predetermined value is externally input.

32. The method according to claim 1, further comprising the segmentation step of segmenting the infrared image signal into a plurality of blocks,

wherein the visible light image signal and infrared image signal are processed for respective blocks.

33. The method according to claim 1, further comprising:

a detection step of detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

a replacement step of replacing, when the signal components corresponding to the holder are detected in the detection step, the signal components by a predetermined signal value.

34. The method according to claim 33, further comprising a step of calculating an average value of the infrared image signal,

wherein the predetermined signal value replaced in the replacement step is the average value.

35. The method according to claim 1, further comprising:

a detection step of detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

a step of removing, when the signal components corresponding to the holder are detected in the detection step, the signal components.

36. A signal processing apparatus for processing a visible light image signal and infrared image signal obtained by illuminating a transparent document with light beams respectively coming from a visible light source for mainly emitting visible light and an infrared light source for mainly emitting infrared light, and photoelectrically converting optical images of the transparent document, comprising:

generation means for generating a histogram on the basis of the infrared image signal;

calculation means for calculating a threshold value on the basis of the histogram generated by said generation means;

extraction means for comparing the threshold value calculated by said calculation means with infrared image signal components, and extracting infrared image signal components not more than the threshold value; and

interpolation means for executing an interpolation process of the visible light image signal on the basis of the infrared image signal components extracted by said extraction means.

37. The apparatus according to claim 36, wherein said interpolation means interpolates visible light image signal components corresponding to the infrared image signal components extracted by said extraction means using surrounding visible light image signal components.

38. The apparatus according to claim 36, wherein said interpolation means interpolates visible light image signal components, which correspond to an image region corresponding to the infrared image signal components extracted by said extraction means, and a region obtained by enlarging the image region by a predetermined size, using surrounding visible light image signal components.

39. The apparatus according to claim 36, wherein said interpolation means interpolates visible light image signal components, which correspond to a region obtained by reducing a region corresponding to the infrared image signal components extracted by said

extraction means by a predetermined size, using surrounding visible light image signal components.

40. The apparatus according to claim 36, further comprising edge correction means for performing edge correction of the infrared image signal,

wherein said generation means generates the histogram on the basis of the infrared image signal that has undergone edge correction, said extraction means extracts infrared image signal components not more than the threshold value by comparing the threshold value calculated by said calculation means with the infrared image signal components that have undergone edge correction, and said interpolation means interpolates visible light image signal components corresponding to the infrared image signal components extracted by said extraction means using surrounding visible light image signal components.

41. The apparatus according to claim 40, wherein an edge correction amount of said edge correction means is set in association with the deterioration of the MTF of the visible light source and infrared light source due to chromatic aberration.

42. The apparatus according to claim 36, wherein said generation means generates a histogram of frequencies of occurrence of respective gray levels of the infrared image signal.

43. The apparatus according to claim 42, wherein said calculation means calculates the threshold value by subtracting a value given by a predetermined relation from a gray level that represents the infrared image signal.

44. The apparatus according to claim 43, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the value to be subtracted on the basis of the standard deviation.

45. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating an intermediate value of the frequencies of occurrence of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the intermediate value.

46. The apparatus according to claim 45, wherein the predetermined value is pre-stored.

47. The apparatus according to claim 45, wherein the predetermined value is externally input.

48. The apparatus according to claim 45, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

49. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating a maximum frequency of occurrence of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the maximum frequency of occurrence of the histogram.

50. The apparatus according to claim 49, wherein the predetermined value is pre-stored.

51. The apparatus according to claim 49, wherein the predetermined value is externally input.

52. The apparatus according to claim 49, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

53. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from the maximum gray level.

54. The apparatus according to claim 53, wherein the predetermined value is pre-stored.

55. The apparatus according to claim 53, wherein the predetermined value is externally input.

56. The apparatus according to claim 53, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

57. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating an average gray level of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from the average gray level.

58. The apparatus according to claim 57, wherein the predetermined value is pre-stored.

59. The apparatus according to claim 57, wherein the predetermined value is externally input.

60. The apparatus according to claim 57, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

61. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram; and

means for calculating the threshold value by multiplying the maximum gray level by a predetermined value.

62. The apparatus according to claim 61, wherein the predetermined value is pre-stored.

63. The apparatus according to claim 61, wherein the predetermined value is externally input.

64. The apparatus according to claim 42, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram;

means for calculating an average gray level of the histogram; and

means for calculating the threshold value by subtracting a product, which is obtained by multiplying a difference between the maximum gray level and the average gray level by a predetermined value, from the average gray level.

65. The apparatus according to claim 64, wherein the predetermined value is pre-stored.

66. The apparatus according to claim 64, wherein the predetermined value is externally input.

67. The apparatus according to claim 36, further comprising segmentation means for segmenting the infrared image signal into a plurality of blocks,

wherein the visible light image signal and infrared image signal are processed for respective blocks.

68. The apparatus according to claim 36, further comprising:

detection means for detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

replacement means for, when said detection means detects the signal components corresponding to the holder, replacing the signal components by a predetermined signal value.

69. The apparatus according to claim 68, further comprising means for calculating an average value of the infrared image signal,

wherein the predetermined signal value replaced by said replacement means is the average value.

70. The apparatus according to claim 36, further comprising:

detection means for detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

means for, when said detection means detects the signal components corresponding to the holder, removing the signal components.

71. An image reading apparatus capable of reading a transparent document, comprising:

a visible light source for mainly emitting visible light;

an infrared light source for mainly emitting infrared light;

a photoelectric converter for converting an optical image into an electrical signal;

generation means for generating a histogram on the basis of an infrared image signal obtained via said photoelectric converter by illuminating a transparent document with light emitted by said infrared light source;

calculation means for calculating a threshold value on the basis of the histogram generated by said generation means;

extraction means for comparing the threshold value calculated by said calculation means with infrared image signal components, and extracting infrared image signal components not more than the threshold value; and

interpolation means for executing an interpolation process of a visible light image signal, obtained via said photoelectric converter by illuminating the transparent document with light emitted by said visible light source, on the basis of the infrared image signal components extracted by said extraction means.

72. The apparatus according to claim 71, wherein said interpolation means interpolates visible light image signal components which correspond to the infrared image signal components extracted by said extraction means, and are obtained via said photoelectric converter by illuminating the transparent document with light emitted by said visible light source, using surrounding visible light image signal components.

73. The apparatus according to claim 71, wherein said interpolation means interpolates visible light image signal components, which correspond to an image region corresponding to the infrared image signal components extracted by said extraction means and a region obtained by enlarging the image region by a predetermined size, obtained via said photoelectric converter by illuminating the transparent document with light emitted by said visible light source using surrounding visible light image signal components.

74. The apparatus according to claim 71, wherein said interpolation means interpolates visible light image signal components, which correspond to a region obtained by reducing a region corresponding to the infrared image signal components extracted by said extraction means by a predetermined size, obtained via said photoelectric converter by illuminating the transparent document with light emitted by said visible

light source using surrounding visible light image signal components.

75. The apparatus according to claim 71, further comprising edge correction means for performing edge correction of the infrared image signal which is obtained via said photoelectric converter by illuminating the transparent document with light emitted by said infrared light source,

wherein said generation means generates the histogram on the basis of the infrared image signal that has undergone edge correction, said extraction means extracts infrared image signal components not more than the threshold value by comparing the threshold value calculated by said calculation means with the infrared image signal components that have undergone edge correction, and said interpolation means interpolates visible light image signal components corresponding to the infrared image signal components extracted by said extraction means using surrounding visible light image signal components.

76. The apparatus according to claim 75, wherein an edge correction amount of said edge correction means is set in association with the deterioration of the MTF of said visible light source and said infrared light source due to chromatic aberration.

77. The apparatus according to claim 71, wherein said generation means generates a histogram of frequencies

of occurrence of respective gray levels of the infrared image signal.

78. The apparatus according to claim 77, wherein said calculation means calculates the threshold value by subtracting a value given by a predetermined relation from a gray level that represents the infrared image signal.

79. The apparatus according to claim 78, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the value to be subtracted on the basis of the standard deviation.

80. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating an intermediate value of the frequencies of occurrence of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the intermediate value.

81. The apparatus according to claim 80, wherein the predetermined value is pre-stored.

82. The apparatus according to claim 80, wherein the predetermined value is externally input.

83. The apparatus according to claim 80, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

84. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating a maximum frequency of occurrence of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from a gray level corresponding to the maximum frequency of occurrence of the histogram.

85. The apparatus according to claim 84, wherein the predetermined value is pre-stored.

86. The apparatus according to claim 84, wherein the predetermined value is externally input.

87. The apparatus according to claim 84, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

88. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from the maximum gray level.

89. The apparatus according to claim 88, wherein the predetermined value is pre-stored.

90. The apparatus according to claim 88, wherein the predetermined value is externally input.

91. The apparatus according to claim 88, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

92. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating an average gray level of the histogram; and

means for calculating the threshold value by subtracting a predetermined value from the average gray level.

93. The apparatus according to claim 92, wherein the predetermined value is pre-stored.

94. The apparatus according to claim 92, wherein the predetermined value is externally input.

95. The apparatus according to claim 92, wherein said calculation means further comprises:

means for calculating a standard deviation; and

means for determining the predetermined value on the basis of the standard deviation.

96. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram; and

means for calculating the threshold value by multiplying the maximum gray level by a predetermined value.

97. The apparatus according to claim 96, wherein the predetermined value is pre-stored.

98. The apparatus according to claim 96, wherein the predetermined value is externally input.

99. The apparatus according to claim 77, wherein said calculation means comprises:

means for calculating a maximum gray level of the histogram;

means for calculating an average gray level of the histogram; and

means for calculating the threshold value by subtracting a product, which is obtained by multiplying a difference between the maximum gray level and the average gray level by a predetermined value, from the average gray level.

100. The apparatus according to claim 99, wherein the predetermined value is pre-stored.

101. The apparatus according to claim 99, wherein the predetermined value is externally input.

102. The apparatus according to claim 71, further comprising segmentation means for segmenting the infrared image signal into a plurality of blocks,

wherein the visible light image signal and infrared image signal are processed for respective blocks.

103. The apparatus according to claim 71, further comprising:

detection means for detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

replacement means for, when said detection means detects the signal components corresponding to the holder, replacing the signal components by a predetermined signal value.

104. The apparatus according to claim 103, further comprising means for calculating an average value of the infrared image signal,

wherein the predetermined signal value replaced by said replacement means is the average value.

105. The apparatus according to claim 71, further comprising:

detection means for detecting signal components corresponding to a holder for holding the transparent document from the infrared image signal components; and

means for, when said detection means detects the signal components corresponding to the holder, removing the signal components.

106. A computer program product comprising a computer usable medium having computer readable program code

means embodied in said medium for a signal processing method for processing a visible light image signal and infrared image signal obtained by illuminating a transparent document with light beams respectively coming from a visible light source for mainly emitting visible light and an infrared light source for mainly emitting infrared light, and photoelectrically converting optical images of the transparent document, said product including:

first computer readable program code means for generating a histogram on the basis of the infrared image signal;

second computer readable program code means for calculating a threshold value on the basis of the generated histogram;

third computer readable program code means for comparing the calculated threshold value with infrared image signal components, and extracting infrared image signal components not more than the threshold value; and

fourth computer readable program code means for executing an interpolation process of the visible light image signal on the basis of the extracted infrared image signal components.